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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number : **0 396 247 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification : **30.11.94 Bulletin 94/48**

(51) Int. Cl.^{5} : **G02F 1/19**, G09G 3/34

(21) Application number : **90303243.1**

(22) Date of filing : **27.03.90**

(54) Dual anode flat panel electrophoretic display apparatus.

(30) Priority : **01.05.89 US 345825**

(43) Date of publication of application : **07.11.90 Bulletin 90/45**

(45) Publication of the grant of the patent : **30.11.94 Bulletin 94/48**

(84) Designated Contracting States : **AT BE CH DE DK ES FR GB GR IT LI LU NL SE**

(56) References cited :
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US-A- 4 742 345
PATENT ABSTRACTS OF JAPAN, vol. 12, no. 488 (P-803)[3335], 20th December 1988 & JP-A-63 200 129

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etic display according to this invention.

FIG. 2 is a cross sectional view of the display of FIG. 1.

FIG. 3 is a front plan view of a typical grid line and also a configuration of a typical local anode line.

Detailed Description of the Figures

Referring to Fig. 1, there is shown a cross sectional view of an electrophoretic display 10 constructed according to the teachings of this invention.

As one can see from FIG. 1, the display 10 basically appears as prior art displays with the exception that there is an additional electrode 16 which will be designated as a local anode as compared to the remote anode 18. The remote anode 18 is the conventional anode associated with the prior art electrophoretic displays. As one will understand, the electrophoretic display as described in many of the prior art patents as above indicated has a viewing area which includes a bottom glass sheet 11. Disposed upon sheet 11 are a plurality of cathode lines 12. These cathode lines 12 are directed in the horizontal or vertical direction and are essentially parallel to one another to form a matrix or grid of lines. Separated from the cathode lines by means of a photoresist or insulator 13 is a plurality of grid lines 14. The grid lines are disposed transverse to the cathode lines and intersect each cathode line to provide an XY matrix arrangement where by a typical pixel area is accessed by addressing a grid and cathode line and thereby providing a desired potential at the intersection between the two lines. This potential causes the migration of electrophoretic particles which are suspended in the electrophoretic suspension and which particles migrate from the grid and cathode structure to the anode 18. The anode 18 is a very thin layer of metal deposited upon a planar glass member 22 according to prior art teachings.

Referring to FIG. 2, there is shown a side cross sectional view of the electrophoretic display. The cathode lines 12 which are thin layers of ITO are deposited upon the glass substrate 11 with the grid lines 14 being perpendicular thereto and insulated from the cathode line by means of insulator layer 13. The thickness of the insulator areas as 13 and 15 is approximately 3 microns with the distance from the top of insulator 15 to the remote anode electrode 18 being about 0.178 mm (7 mils). As seen more clearly in FIG. 2, each grid line 14 is separated from a local anode line 16 by means of an insulator layer 15.

In this manner the local anode 16 is of the same exact configuration as the grid structure 14. The anode 16 is separated from the grid by the insulating layer 15 and is configured the same as the grid structure. Thus, there are as many anode segments as there are grid segments. Each segment of the anode can have the same exact configuration as the grid. For example, U.S. 4,742,345 describes a grid structure fabricated with respect to the cathode structure in the configuration depicted in FIG. 3. As one can see from FIG. 3, each of the grids is fabricated by utilizing deposited metal on an insulator whereby a top conductive area or contact area 30 is provided which conductive area 30 is above a bottom conductive area 31. Disposed between areas 30 and 31 are a series of tines 32 which are grid conductors.

As one can understand, the parallel conductor members 32 as connected in parallel by the contact pair 30 and 31 provide a plurality of intersecting points for each of the grid structures with respect to the cathode line. The advantage of such an arrangement has been fully explained and described in U.S. 4,742,345. If the grid structure of FIG. 3 is employed then the anode structure 16 will follow the grid structure. In this manner it is seen that the local anode 16 may consist of a plurality of parallel lines each of which is associated with a grid line with each of the parallel lines being dimensioned and congruent with each of the associated grid lines.

One can, of course, connect all the anode lines together at both contact areas 30 and 31 or one can drive each of the anode lines separately or in groups. As will be explained if the anode lines are separately driven or driven in regard to associated groups then one can achieve selective erasing as well as selective writing with this display. For purposes of explaining the operation of the unique flat panel display depicted in FIG. 1 and FIG. 2, first assume that all the anode segments 16 or anode lines are connected in parallel. In this manner the operation is as follows.

To obtain a full ERASE from the remote anode 18, one applies a negative high voltage to the remote anode 18 which for example is -200 volts. One then applies a negative low voltage to the local anode 16 or to each of the local anode lines 16 of -15 volts. In this manner one then keeps the grid at a low voltage as for example -12 volts and keeps the cathode lines at a high voltage which is +15 volts. These biasing levels operate to ERASE the display and cause all the pigment to be transported to the surface of the grid and cathode. During a first HOLD mode, the excess pigment is brought to the remote anode 18. In this first HOLD mode the anode 18 which is the remote anode is held at a positive high voltage which may be for example +200 volts. The local anode 16 is placed at a positive low voltage which is +15 volts and the grid and cathode are held at -12 volts and +15 volts respectively as indicated above for the full ERASE mode. This first HOLD mode operates to bring the excess pigment to the remote anode as described above. As one can ascertain, the brightness of the display between HOLD and ERASE differs as described above.

In a second HOLD mode anode voltage 18 is biased at a positive low voltage which is +15 volts

and different anode structure which is a series of lines congruent with and insulated from the grid lines. The second anode line structure can have all lines connected together at both top and bottom as described above or each of the anode lines can be separately addressed. The anode is for example fabricated from aluminum with the grid being fabricated from chrome. In this manner one can utilize different etchants to form the local anode structure 16 as compared to the typical grid structure 14 and hence obtain all the benefits of the above-noted structure.

Claims

1. An electrophoretic display (10) of the type having a cathode structure comprising a plurality of electrically conductive lines (12) arranged in a given direction, with a grid structure insulated from said cathode structure and comprising a plurality of electrically conductive grid lines (14) each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode (18) separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion (17) including pigment particles suspended in a fluid, characterized by:

   an additional anode electrode (16) comprising a plurality of electrically conductive parallel lines each associated with and insulated from a respective grid line (14) of said grid structure with said additional anode (16) operative when biased to control the path of said pigment particles to and from said grid and cathode matrix (X-Y) and to allow excess pigment to remain at said conventional anode electrode (18).

2. The electrophoretic display according to Claim 1, wherein said additional anode lines (16) are of the same configuration as said grid lines (14).

3. The electrophoretic display according to Claim 2, wherein said grid lines (14) are fabricated from chrome with said additional anode lines (16) fabricated from aluminum.

4. The electrophoretic display apparatus according to Claim 1, wherein said additional anode lines (16) are connected together.

5. The electrophoretic display according to Claim 1, wherein groups of said anode lines (16) are connected together to enable selective ERASING of said display.

6. The electrophoretic display according to Claim 1, wherein said additional anode lines (16) as insulated from said grid lines (14) are separated therefrom by between 2-5 micrometer.

7. The electrophoretic display according to Claim 6, wherein each one of said grid lines (14) is of a tine-like configuration comprising a plurality of parallel lines (32) coupled together at a top contact (30) and a bottom contact (31).

8. The electrophoretic display according to Claim 1, wherein said cathode lines (12) are fabricated from ITO.

9. The electrophoretic display according to Claim 8, wherein said cathode lines are deposited on a planar member of glass (11).

Patentansprüche

1. Elektrophoretische Anzeigevorrichtung (10) des Typs mit einer Kathodenstruktur, die eine Vielzahl von elektrisch leitenden, in einer gegebenen Richtung angeordneten Leitungen (12) aufweist, mit einer Gitterstruktur, die von der Kathodenstruktur isoliert ist und eine Vielzahl von elektrisch leitenden Gitterleitungen (14) aufweist, die jeweils senkrecht zu den Kathodenleitungen liegen, um eine X-Y-Adressiermatrix mit einer herkömmlichen, von der X-Y-Matrix getrennten Anodenelektrode (18) zu bilden, wobei der Raum zwischen der Anodenelektrode und der X-Y-Matrix eine elektrophoretische Dispersion (17) aufnimmt, die in einem Fluid suspendierte Pigmentteilchen umfaßt, gekennzeichnet durch:

   eine zusätzliche Anodenelektrode (16), die eine Vielzahl von elektrisch leitenden, parallelen Leitungen aufweist, die jeweils einer entsprechenden Gitterleitung (14) der Gitterstruktur zugeordnet und davon isoliert sind, wobei die zusätzliche Anode (16) bei Vorspannung wirksam ist, um den Pfad der Pigmentteilchen zu und von der Gitterund Kathodenmatrix (X-Y) zu steuern und zuzulassen, daß überschüssige Pigmente an der herkömmlichen Anodenelektrode (18) bleiben.

2. Elektrophoretische Anzeigevorrichtung nach Anspruch 1, bei welcher die zusätzlichen Anodenleitungen (16) die gleiche Ausgestaltung wie die Gitterleitungen (14) aufweisen.

3. Elektrophoretische Anzeigevorrichtung nach Anspruch 2, bei welcher die Gitterleitungen (14) aus Chrom hergestellt sind, wobei die zusätzlichen Anodenleitungen (16) aus Aluminium hergestellt sind.

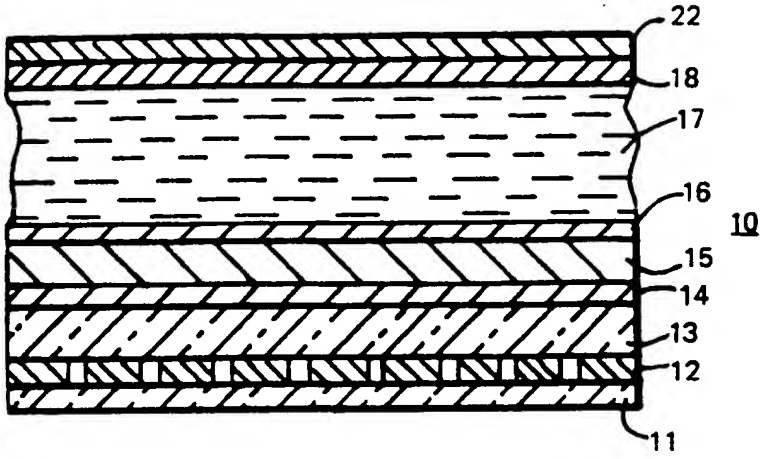

FIG. 1

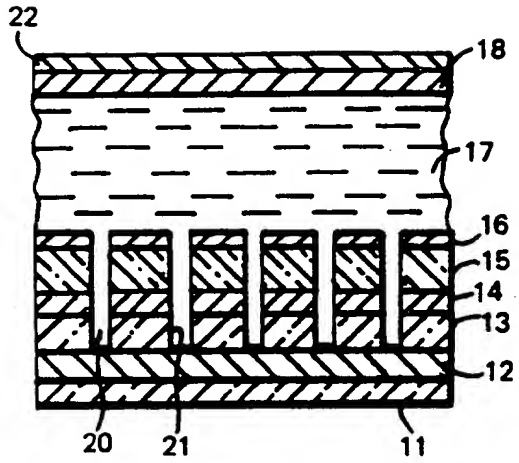

FIG. 2

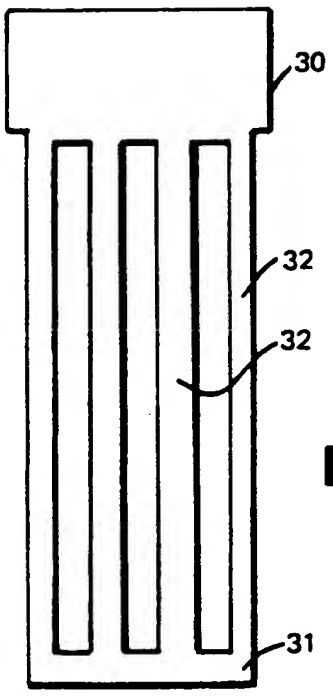

FIG. 3